

The background of the entire page is filled with various pink silhouettes of plastic bottles and containers. These include a large rectangular bottle, a small bottle, a wide-mouthed bottle, a standard water bottle, a soda bottle, and a large bottle lying on its side. The silhouettes are arranged in a way that they appear to be floating or scattered across the white background.

PLASTICS CHALLENGE

Teacher's guide



practicalaction.org/schools/plastics-challenge

**Practical
ACTION**

The Plastics challenge provides pupils aged 8-14 years with opportunities to apply their STEM skills to address a number of problems caused by waste plastic globally.

The materials within the challenge have been designed for you to use flexibly. The starter activities, practical science investigations and main design and make challenge can be used as part of the formal science or design and technology curriculum in a STEM club and/or a curriculum enrichment day.

It can also be used by pupils to gain a CREST Award and to enter regional Big Bang events. For more information see page 10.

The challenge draws upon Practical Action's work in Nepal with waste collectors and entrepreneurs who reuse plastics. It also demonstrates how such development projects contributes towards reaching the Sustainable Development Goal (SDGs) targets for 2030.

This teacher's guide is supported with pupil activity sheets, a Power Point (PPT) presentation, poster and certificates. They can be downloaded from: practicalaction.org/schools/plastics-challenge

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Learning objectives

Pupils have the opportunity to:

- engage in scientific enquiries to that explore the impact and efficacy of recycling
- learn about the impact of plastic waste in the UK and globally
- investigate how bioplastics are made
- design and make a marketable product from waste plastic.

Curriculum links

STEM subjects provide great opportunities for teachers to include authentic global contexts and global learning. To see where the Plastics challenge supports the delivery of the formal science curriculum for England, Northern Ireland, Scotland and Wales please go to: practicalaction.org/schools/science-curriculum.

Within the D&T curriculum pupils will gain technical skills and knowledge.

Overview of Plastics challenge

Outline	Teaching material	Timing (min)
Introduction to the context	PPT slides 1–3 Pupil activity sheet (one per group) – What do you see?	10 mins
Starter activities a. Sorting plastics b. Decomposition timeline c. Lifecycle of plastics d. Plastics recycling: True or False e. Sustainable Development Goals	PPT slides 4 – 14 Pupil activity sheets (one per group) – Plastics information chart – Waste timeline sheet – Lifecycle analysis picture cards – Lifecycle analysis sheet (A3 for younger pupils) – Plastics recycling: True or False? – Sustainable Development Goals	10 min 15 min 15 min 10 min 10 min
Science investigations a. Mystery plastics b. Chemistry of plastics c. Bioplastics	PPT slides 15–16 Pupil activity sheets (one per group) – Identifying plastics sheets – Plastics information sheet – Plastic sorting key – Plastic polymers sheet (optional) – Set of chemistry of plastic sheets (chemical formulas, molecular structure, compound names, type of plastic, recycle code, uses) – Plastic information chart – Making bioplastic sheet – Graphic organiser	15 min 15 min 25 min
Main activity – the Plastics challenge a. Who is my product aimed at? b. What's the specification? c. Learning from other designers and makers d. Techniques for reusing plastics e. Designing, making and evaluating	PPT slides 17–20 Pupil activity sheets (one per group) – Design contexts – Project outline and design criteria – Who is my product aimed at? – What's the specification? – Research – What can I do with plastics? – Making a notebook and Making plastic bunting. – Product design (Design ideas and Final design) – Product evaluation	1–5 hrs
Feedback	PPT slide 21 Pupil activity sheet (one per group) – Team feedback	30 min
Ingenious solutions	PPT slides 23–24 Pupil activity sheet (one per group) – Sustainable Development Goals	5 min
Celebrating success	PPT slides 25–27	5 min

Introduction to the context

We recommend that you use the *What do you see?* activity to introduce the context of waste plastics for the challenge.

Split the pupils into small groups and give each group a set of the *What do you see?* photographs.

Allow the pupils to spend time looking at the photographs and provide them with the prompt questions on PowerPoint (PPT) slide 2.

Prompt questions

- What do you see?
- What questions do the photographs raise for you?
- What do think might be the problems for people and the environment?

Enable pupils to feedback on their thoughts. Then use the PPT slides 3-4 to provide more specific information about the photographs and plastic waste in the UK and Nepal. Share with the pupils that they'll be learning more about the waste collectors and entrepreneurs from Nepal throughout the project.

Starter activities

a. Sorting plastics

This activity helps pupils to learn about different types of plastics and their range of uses.

Organise the class so that the pupils are working in small groups.

Use PPT slide 5 to introduce how in Nepal, two boys (Sayeed and Sunil) are sorting plastics into different types.

Give each group their bag and ask them to sort the plastics in a way that they think would most likely generate the most income for them from a plastic scrap dealer. PPT slide 6 explains the activity.

After a few minutes ask pupils to feedback on their reasons for sorting the plastics the way they have.

with a number on it to sort their plastics. If they haven't noticed these symbols then bring them to their attention. Explain that sorting plastics into these symbol categories maximises their potential for reuse or recycling.

For older and/or more able pupils you might choose to share the *Plastics information chart* for them to see the different symbols and the names of the plastics, typical uses, etc.

Resources

Pupil activity sheet (one per group)

- *Plastics information chart*

Equipment (one set per group)

- 1 bag containing a variety of different waste plastic items e.g.: yoghurt pots, plastic bags, shampoo bottle, etc.

b. Decomposition timeline

This activity enables pupils to gain awareness that different materials take different times to decompose and therefore have varying impacts on the environment if they end up in landfill.

Organise the class into small groups. Give each group the Waste timeline sheet (or set of cards if cut out beforehand).

Introduce the activity by asking pupils what they think happens to various items on their cards once people have finished with them.

Suggest to the pupils that if the items were thrown away in a 'normal' bin (rather than recycled or composted) the items would end up in a landfill site.

Check pupils understanding of the term 'decompose' then ask them to place their cards from fastest to slowest material to decompose on the table in front of them. The activity is shown on PPT slide 7.

Discuss the pupils' timelines and show PPT slide 8 showing the correct order of decomposition. Now ask pupils for their ideas of how long they think it takes for the various items to decompose. Reveal the answers using the PPT slide 9 or read them out from the information on page 4.

Waste timeline: Approximate time taken for items to decompose

Teabag (1 month), banana peel (6 weeks), apple core (2 months), woollen sock (1 year), thin plastic bag (20 years), magazine (50 years), plastic bottle (450 years), mobile phone (1000 years).

Discuss with the pupils if they think it's a problem that some items, particularly plastics and electrical goods take so long to decompose. What can we do about it?

Resources

Pupil activity sheets (one per group)

– *Waste timeline sheet*

Equipment (one set per group)

– *Items from the Waste timeline sheet e.g. teabag, plastic bottle (optional), scissors.*

c. Lifecycle of plastics

This activity helps pupils to understand how plastics are made and the environmental impact they cause at different stages of the lifecycle.

Start this activity by asking how many plastic drinks bottles the pupils use in an average day or week.

Then hand out a drinks bottle and a set of *Lifecycle analysis picture cards* to each group. Allow a few minutes for the pupils to arrange the cards in a way that tells the story of the drinks bottle from beginning to end. Ask for feedback on their story line.

Using the PPT slide 10 to introduce Lifecycle analysis (LCA). Give each group a copy of the *Lifecycle analysis sheet* and introduce the idea that carrying out a lifecycle analysis is a good way of identifying how and where a product causes environmental impact.

Now ask them to discuss the questions about ways to reduce the environmental impact of the plastic bottle and record their answers on the sheet. Give time for feedback of their ideas.

For more able or older pupils you might like to extend their thinking by using the 4Rs to help

identify areas to reduce environmental impact. This is presented on PPT slide 11.

4Rs: Rethink, Reduce, Reuse, Recycle

Rethink: Do we need to use plastic bottles at all? What could we use instead? Can we use other raw materials to make plastic?

Reduce: Can we use less material or energy to make the bottles? i.e.: thinner plastic

Reuse: Can we reuse a plastic bottle? How can we make that safe? What could we do to encourage people to reuse a bottle?

Recycle: Can we encourage people to recycle more plastic bottles? Can a bottle be designed in a way to make recycling easier which would improve the efficacy of recycling? i.e.: use single plastics.

Resources

Pupil activity sheets (one per group)

– *Lifecycle analysis picture cards*
– *Lifecycle analysis sheet* (copied to A3 for younger pupils)

Equipment (one set per group)

– A plastic drinks bottle, one pair of scissors

d. Recycling plastic – True or false?

This activity enables pupils to learn about recycling plastics and to challenge some of the common misconceptions about recycling plastic.

In their small groups, ask the pupils to read out the statements one at a time from the *Recycling plastic: True or False?* cards. They need to discuss and decide whether the statements are true or false and make a pile of each. This activity is explained on PPT slide 12.

Once the pupils have finished – you can reveal to them that all of the facts on the cards are true!

Resources

Pupil activity sheet (one per group)

– *Plastics recycling: True or False? sheet*

Equipment (one set per group)

– One pair of scissors

e. Sustainable Development Goals

Whether you have run a few starter activities and/or the practical science investigations we hope that your pupils will have a clear sense that plastics are causing huge problems for people and the planet.

Throughout all of our STEM challenges we want pupils to learn how organisations and individuals (including themselves) can play a role in finding solutions to address such problems as pollution caused by plastics. The United Nations (UN) are one body who are addressing big global problems through the Sustainable Development Goals (SDGs).

In 2015 the United Nations worked with leaders from across the globe to identify the big challenges for the world that need collective action to resolve.

Seventeen areas were identified. They are called the Sustainable Development Goals (SDGs), or Global Goals for short. Each goal has a set of targets to be reached by 2030.

Use PPT slides 13-14 to introduce the Global Goals to your pupils. We suggest you share the *Sustainable Development Goals* pupil sheet with each targets explained. Then ask them which of the Global Goals relate to the problems caused by plastics.



Homework or extension activity

If you choose to explore the Global Goals in more detail, we recommend our Global Goals: String Activity and Who's responsible?
practicalaction.org/schools/sdgs

Science investigations with plastics

The following investigations are designed to extend your pupils' knowledge and understanding of the science behind plastics. They vary in length and complexity, so we suggest you select the most appropriate investigations for your pupils and time available.

a. Mystery plastics?

This activity enables pupils to identify four different plastics using simple tests and a key to compare properties.

Organise the class into small groups and explain that sometimes plastics are not marked with a symbol and it makes it hard to tell which plastics they are. The only way to sort them is through testing their properties.

Demonstrate the four tests for the pupils to carry out on the four samples. They are tests for opacity, flexibility, how the plastics cut/mark and whether they float or sink. The activity is explained on PPT slide 15.

NB. Go to CLEAPSS.org.uk for guidance on how to do these activities this safely with your pupils.

As the pupils test each plastic, encourage them to record their observations on the *Identifying plastics* sheet. Then ask the pupils to use their observations of the four samples and the *Plastics sorting key* to identify the four plastics.

The mystery plastics are:

- 1: Low density polyethylene (LDPE)
- 2: High density polyethylene (HDPE)
- 3: Polypropylene (PP)
- 4: Un-plasticised polyvinyl chloride (UPVC)

These answers are on PPT slide 16.

Resources

Pupil activity sheet (one per group)

- *Identifying plastics sheets*
- *Information sheet*
- *Plastic sorting key*

Equipment

- 1 x 5cm cut samples of the plastics (Low density polyethylene (LDPE), High density polyethylene (HDPE), Polypropylene (PP), Un-plasticised polyvinyl chloride (UPVC))
- Bowl of water
- Scissors or small nail
- Torch

b. Chemistry of plastics

Used in full this activity is suitable for more able or pupils aged 14+. It reinforces prior learning on plastic polymers, atomic structures, molecular formulae in relation to different types of plastics. It can also be differentiated by choosing two or three of the simpler card to match up.

It makes a good follow on, or extension activity to investigation a) Mystery plastics.

Organise the class into small groups. You may wish to show the pupils a video clip on how different plastics are made. We recommend the 2mins clip, The Plastic revolution bit.ly/bbcbitesize-plastic. Recap on the main points of learning.

Depending on the ability of the groups select and hand out the relevant sheets from the set of Chemistry of plastics and the Plastics information sheet. Ask the pupils to match each of the six plastics with their relevant cards. Pupils can check their results by looking at the information chart. Review their findings.

NB. For more able pupils you might choose to introduce the- *Plastics polymers* sheet to explain or recap on polymerisation and explain that plastics are composed of different molecules (called monomers) joined together which gives them different properties.

Homework or extension activity

Find out about the different job roles of scientists and chemical engineers who are involved in developing plastics and/or deal with plastic waste/recycling.

Resources

Pupil activity sheet (one per group)

- *Chemistry of plastic sheets* (Chemical formulas, Molecular structure, Compound names, type of plastic, Recycle code, Uses)
- *Plastic polymers sheet* (optional)
- *Plastic information chart*

c. Bioplastics

This investigation enables pupils to make bio plastics as an alternative to oil based plastics. You might choose to demonstrate or allow the pupils to follow the instructions on the *Making bioplastics sheet*.

Go to CLEAPSS.org.uk for guidance on how to do this activity safely with your pupils.

Homework or extension activity

As a follow on activity ask pupils to use the internet to research into oil based plastics versus bioplastics.

Each pupil will need a *Graphic organiser sheet* to structure their research and record their findings. Before the pupils get started, you may wish to check pupils understanding of key terms such as renewable/non-renewable, decompose, etc. and discuss search terms before they use the internet.

Resources

Pupil activity sheet (one per group)

- *Making bioplastic sheet*
- *Graphic organiser* (per pupil)

Equipment

- Ingredients and equipment from *Making bioplastic sheet*

The main activity – the Plastics challenge

This is the main designing and making part of the challenge, where pupils explore the many ways that plastics can be reused.

The challenge works well if pupils are working in small groups.

The increased use of plastics globally is creating huge environmental problems for both industrialised and developing countries. Pupils will address the problem of waste plastics in their challenge (shown on PPT slide 17).

There are two contexts for them (or you) to select (shown on PPT slide 18-20). The contexts are also presented within the pupil activity sheets *Design contexts*.

a) The Hamro Mahila Women's Group in Nepal was set up after a group of women 'waste' collectors were trained and supported by Practical Action in making crafts from 'waste' plastic. Their enterprise enables them to earn money to buy food and pay for school fees for their children.

The challenge is to design a product (or range of) that could help the group to increase their range of products to sell for a local or international market.

b) A new Eco-enterprise company have decided to take on 'The £5 challenge' which aims to create a business idea with a start-up fund of £5. Your challenge is to design and make a high quality product that reuses plastic and can be sold to a consumer of your choice.

Hand out the pupils *Project outline* and *Design criteria sheet*. Ask them to record in their own work their chosen design context.

NB: If you are planning for your pupils to gain a CREST Discovery Award from this challenge a project presentation is a requirement. PPT slide 20 gives pupils ideas of what to include in their presentations.

Activities to support pupils with their challenge

The following activities have been developed to help pupils develop high quality ideas and products for their chosen context and user. They are supported with pupil activity sheets. They include:

a) Who is my product aimed at?

This activity helps pupils to understand the importance of defining who they are aiming the product at, so that it meets the needs of the intended group.

Hand out the *Who is my product aimed at?* sheet and ask the pupils to discuss and decide who they feel they would like to develop their product for.

If they are not sure that any of the profiles are suitable, ask them to develop a profile for a group of their choice.

Now ask them to think about the features/ characteristics that the product should have to meet these needs of the people they are designing for.

Ask the pupils to record who they are designing their product for on their *Project outline* and *Design criteria sheet*.

b) What's the specification?

This activity helps pupils to build on the criteria they identified to meet the needs of their user. The additional criteria include social, economic and environmental issues.

Hand out the *What's the specification?* ideas for design criteria to each group of pupils and ask them to identify which of the criteria they feel are most important for their product.

We suggest you encourage them to select 4-5 (depending on their age and ability). Ask the pupils to record on their criteria on their *Project outline* and *Design criteria sheet*.

c) Learning from other designers and makers

There are lots of designers and makers who are choosing to use 'waste' and/or recycled materials to make new products.

We recommend that you give pupils the opportunity to look at some of these products, either

online or through sourcing products made from reused plastic. If you choose to do this you might want to get the pupils to record their research findings on the *Research sheets*.

Designers and makers who reuse plastics

- Bottle vase ([.bit.ly/youtube-reuse-plastic-bottle](https://bit.ly/youtube-reuse-plastic-bottle))
- Fusing plastic bags ([bit.ly/ youtube-fuse-plastic-bags](https://bit.ly/youtube-fuse-plastic-bags))
- Cutting plastic bags for weaving (bit.ly/plastic-bags-weaving)
- Knitting with plastic bags (bit.ly/plastic-bags-knitting)

d) Techniques for reusing plastics

Before the pupils start developing ideas for their products, we recommend spending a little time enabling them to experiment with techniques for re-using plastics, including cutting, knitting, fusing plastics, etc. The activity sheet *What can I do with plastics?* supports this activity.

Ask pupils to keep their work samples, so that they can include them at a later stage on their design sheets.

For pupils who need more support to develop their ideas, and design and make their own product, there are two step by step guides to *Making a notebook* and *Making plastic bunting*. Both products can be adapted.

e) Designing, making and evaluating

A set of *Product design sheets* (*Design ideas*, *Final ideas*, *Product plan*) are available for pupils to capture their ideas for developing and presenting their product. The evaluation activity is explained on PPT slide 22.

Activity

For older and/or more able pupils you might want to extend their learning with the 4P's (Product, Price, Promotion and Placement) activity sheet. It encourages pupils to plan their marketing and selling strategy.

Feedback

We suggest that pupils present their product to the rest of the class reflecting on how well they worked together, problems they solved, etc. (this will be necessary if you are planning for your pupils to gain a CREST Discovery Award). The criteria is shown on PPT slide 21.

Pupils are asked to comment on:

Teamwork – Did they assign roles well and work together as a team?

Research – Did they use their research to make recommendations for the best use of the solar cells.

Developing and finalising ideas – Did they develop ideas that met the needs of the community?

Presentation – How well did the team communicate about their Plastics challenge?

Resources

Pupil activity sheet

- *Team feedback* (one per pupil)

Ingenious solutions

When your pupils have completed their project you might like to show them some of the products that the Hamro Mahila Women's Group in Nepal are making and selling locally.

Their profits are making a big difference to the women's lives. They now have more money to feed their families, buy school uniforms and invest in developing their enterprise.

The video clip below shows Practical Action's work with waste collectors and the women's group reusing plastic waste to make new products.

youtu.be/69Pc5A_dU2E

Earlier in the Plastics challenge project, the pupils learnt about the Sustainable Development Goals (SDGs).

Spend a few minutes asking the pupils to look at the Sustainable Development Goals sheet and/or PPT slides 23–24, then to consider how the Women's enterprise is helping to reach some of the SDG targets. Have a discussion about which Global Goals in particular they think are being reached.

Celebrating success

CREST Awards

Taking part in the Plastics challenge is a great way for pupils to gain a CREST Award. The challenge is aligned to the Discovery Award, but can be used towards achieving a Superstar Award or as the starting point for a Bronze, Silver or Gold Award.

The CREST Discovery Award is generally undertaken by 9–14 year olds. It can be achieved in 3–5 hours. CREST Bronze, Silver and Gold Awards are designed for pupils aged 11–18.

For more information on CREST Awards go to:
crestawards.org

For further ideas for Bronze, Silver and Gold projects linked to global issues go to:
practicalaction.org/schools/global-project-ideas



Big Bang Competition

Pupils aged 11–18 and in full time education/training who have taken part in a STEM challenge can enter their work into the National Big Bang Competition.

Prizes include industry/scientific site visits, and a chance to represent the UK at international contests. Being a part of the competition is an inspiring and valuable experience for all young people involved.

To find out more go to:
competition.thebigbangfair.co.uk



Great Science Share for Schools

Having taken part in the challenge, pupils are encouraged to join in the annual Great Science Share for Schools campaign. It's their chance to share their project with new audiences in or beyond their own schools. To find out more and register your school to take part visit: greatscienceshare.org



British Science Week

The Solar challenge would be a great activity for your class or year group to do during British Science week in March each year. To find out more go to:
britishscienceweek.org.

To find out if your school is eligible for a grant go to:
britishscienceweek.org/about-us/grants

